Impact of Fly Ash on The Wetland Ecosystem of Budge Budge, South 24 Parganas District, West Bengal

SYNOPSIS FOR Ph.D. REGISTRATION IN GEOGRAPHY

(FACULTY OF SOCIAL SCIENCE)

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2023

1. A brief introduction of the research topic

Budge Budge Thermal Power Plant (TPP) is a coal-based power generating station. It is situated at Pujali, Budge Budge, South 24 Parganas District in West Bengal, India. The coal consumption in TPPs generates fly ash estimated up to 12.21 million tons to the environment per year (Ghosh et al., 2015) and disposal of such huge amount of fly ash is a major problem at present. Excess disposal of fly ash from the Budge Budge Thermal Power Plant to nearby aquatic bodies like different wetlands, ponds, canals, and the contamination caused during rainy season has become a serious threat not only to the surrounding areas but has also caused serious health problem. In the light of the above ground, this research intends to investigate the impact of fly ash generated from the Budge Budge Thermal Power Plant on its nearby wetland ecosystem. The research aims to study how toxic elements of fly ash can damage and alter the different physico-chemical parameters of water, soil, flora, and fauna and destroy the balance of the wetland ecosystem. In the recent past, various researches have been ongoing mainly on effective use and management of the fly ash. But it's effect on various physico-chemical parameters as well as the biotic components of the environment have not been highlighted. This research work is focused on impact of fly ash on the wetland ecosystem at the surrounding area of Budge Budge Thermal Power Plant Generating Station in South 24 Parganas District, West Bengal which was not done by any other researchers previously.

2. State-of-the-art

Wetlands are transitional areas where water meets land, creating habitats characterized by the presence of saturated or seasonally saturated soil. Wetlands, often referred to as the Earth's kidneys, are unique and diverse ecosystems that play a crucial role in maintaining the health of our planet (Bera 2016). These waterlogged landscapes are home to a wide array of plant and animal species, provide essential ecological services, and act as natural buffers against the impacts of climate change. Generally, two categories of wetlands are recognized: coastal or tidal wetlands and inland or non-tidal wetlands. Wetlands encompass a wide range of environments, including subcategories such as marshes, swamps, bogs, and fens, both tidal and non-tidal. Wetlands are renowned for their extraordinary biodiversity. (Arya et al., 2020, Xu et al., 2020). These ecosystems are havens for numerous plant and animal species, serving as nurseries, breeding grounds, and resting places for migratory birds. The diverse vegetation found in wetlands provides food and shelter for an array of insects, amphibians, reptiles, mammals, and aquatic organisms. From rare orchids and water lilies to endangered birds and fish, wetlands are teeming with life, making them invaluable reservoirs of biodiversity. Wetlands are natural powerhouses that deliver a broad range of ecological services. Firstly, they act as filters, purifying water by trapping sediments and pollutants, thereby improving water quality. Moreover, wetlands regulate water flow, mitigating floods by absorbing excess rainfall and slowly releasing water during dry periods, which helps in preventing downstream flooding and erosion. They also recharge groundwater, maintain water tables, and act as natural reservoirs during droughts (Alam 2014, Alikhani et al. 2021). Wetlands play an integral role in

climate change mitigation efforts. By conserving wetlands, we can contribute to global efforts to combat climate change and its impacts. Beyond their ecological significance, wetlands offer numerous economic and societal benefits. They support fisheries, providing food security and livelihoods for local communities. Wetlands are also popular tourist destinations that attract nature enthusiasts, birdwatchers, and eco-tourists, which may contribute to improve the local economy. Moreover, wetlands serve as educational and recreational spaces, fostering a sense of connection to nature and promoting physical and mental well-being.

Despite their ecological importance, wetlands face a range of threats. Urbanization, agricultural expansion, drainage for infrastructure development, and pollution pose significant risks to these delicate ecosystems (Bassi et al., 2014, Arya et al., 2020, Alikhani et al., 2021). Climate change exacerbates these challenges, leading to sea-level rise, altered precipitation patterns, and increased frequency and intensity of weather events. Loss and degradation of wetlands result in the loss of biodiversity, reduced water quality, decreased resilience to climate change, and diminished ecological services.

In the recent decades, power generation has increased manifold in India to meet the demand of the increasing population [Jamil et al. 2009, Yao et al. 2015]. Seventy percent of electricity is generated by coal-based thermal power plants (TPPs) [Usmani and Kumar 2017] and currently 82 coal-fired TPPs exist in India of which 16 are in West Bengal. Fly ash is basically the waste material produced on the combustion of coal in power station. It is extracted from flue gases through Electrostatic Precipitator (ESP) in dry form. The coal consumption in TPPs generates fly ash estimated up to 12.21 million tonnes to the environment per year [Vasistha 2014, Usmani, and Kumar 2016]. Fly ash contains major elements like Silica (Si), Calcium (Ca), Magnesium (Mg), Potassium (K), Phosphorous (P) and Sulphur (S). It also contains trace amount of some heavy metals like Molybdenum (Mo), Mercury (Hg), Selenium (Se) Lade (Pb) and Cadmium (Cd) etc. (Ghosh et al., 2015).Environmental pollution by the coal based TPP all over the globe is cited to be one of the major sources of pollution affecting the general aesthetics of our environment in terms of air, soil, water pollution, land use and health hazards (Mandal and Sengupta, 2005; Moon and Dermatas, 2007). The coal fly ashes occupy more space in the premises of industrial plants (Flanders, 1999) and are mixed with water to discharge into fly ash settling ponds or landfills. Large quantities of coal fly ashes are stored in the form of waste heaps or deposits, whose contamination poses a serious threat to the environment in general and can have deleterious effects on soils, surface water, and ground water (Moon and Dermatas, 2007), human health (Yuan *et al.*, 2009), growth rate of major carps (Klose *et al.*, 2001) and even biotic organisms like fishes (Shrivastava and Dwivedi, 2011). With the present practice of fly-ash disposal in ash ponds (generally in the form of slurry), the total land required for ash disposal would be about 82,200 Hectares by the year 2020 (CBRI ENVIS Centre on Fly Ash, 2011). So, some attempts are warranted to find the constituents of the fly ash coming out of for their proper disposal and treatment in view of safety aspects and it is rather necessary to treat Fly Ash as a byproduct rather than waste (Behera, 2010; Dwivedi and Jain, 2014).

Disposal of the increasing amounts of fly ash is becoming a serious concern to the environmentalists as the re-use/utilization rate is too low and inadequate or unscientific

management results into multi-furious geo-environmental degradation (Ghosh et al., 2015). Due to the pressure of population growth and expansion of agricultural fields, fly ash is being dumped in ponds, canals, wetlands, swamps etc. As a result, physical (air, water, and soil) and cultural (human life and architecture) environment are hindering for the reason of excessive emission/ production of fly ash.

3. Problem to be investigated

Excessive disposal of fly ash from the Budge Budge Thermal Power Plant to nearby aquatic bodies like wetlands, ponds, and canals, along with overflow during the rainy season, poses a significant threat to the surrounding area and human health. The present research aims to study the impact of fly ash on the nearby wetland ecosystem. It will investigate how toxic elements from the fly ash can alter and disturb the physico-chemical parameters of water and soil in the wetland. Additionally, the harmful effects of fly ash on the frequency, abundance, and diversity of major plant and animal species in the wetland ecosystem will be examined.

4. Objectives of the investigation and motivation

The major objectives of the study should be-

i) To determine the impact of fly ash on the different physico-chemical parameters of water of wetland ecosystem.
ii) To assess the effect of fly ash on the different soil parameters of wetland ecosystem.
iii) To measure the influence of fly ash on the frequency, abundance, and diversity of different floral populations of the wetland ecosystem.
iv) To quantify the impact of fly ash on the frequency, abundance, and diversity of various faunal populations exist in the wetland ecosystem.
v) To evaluate the socio-economic values of the floral and faunal ingredients of the wetland ecosystem.

5. Hypotheses

The hypothesis of the proposed work should be as follows-

i) Fly ash content of thermal power plants may have an impact on the physico-chemical parameters of the water of the wetland.
ii) This fly ash content may exert toxic effect on the soil parameters of the wetland.
iii) This fly ash content may also affect the species frequency, abundance and diversity of the flora and fauna of the wetland ecosystem

6. Research design, Methodology, Chapterization

Research design

Research may be defined as systematic attempt to obtain meaningful answers to the questions about events of situations. Research implies scientific methods and follows a systematic procedure. Methodology constitutes an overview of the layout including the details how the research is to be executed. This includes the blueprint for the collection, measurement, and analysis of data. It includes the overall methods of data processing and plan of analysis. The present study is an example of experimental research.

The title of the present research is "Impact of fly ash on the wetland ecosystem of Budge Budge, South 24 Parganas District, West Bengal. The topic chosen by me with the help of my supervisor will be experimental research. This study has been designed through the following steps-

i) Collection of samples (through the field study)
ii) Test of samples (through the laboratory experiments)
iii) Interpretation of data (based on the experimental results)
iv) Statistical analysis and graphical presentation

Methodology

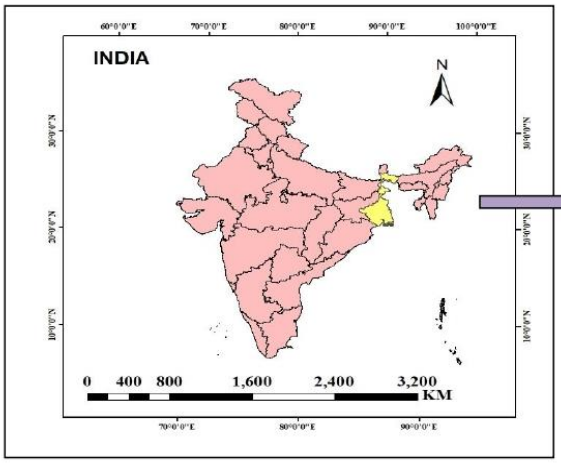
i) Description of study area

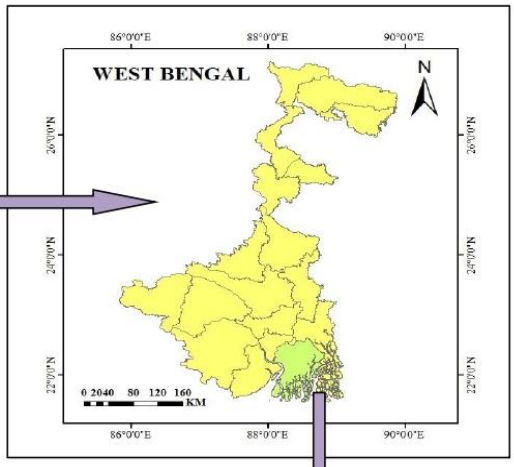
We would like to select three fly ash exposed wetland areas that are situated at the surrounding areas of Budge Budge Thermal Power Plant Generating station as follows- Site-1: Rajarampur (22° 27′ 45.5″ N & 88° 08′ 11.5″E; Size-91.05 Hectare approx.), Site-2: Achipur (22° 46′ 08″ N & 88°12′ 21″ E; Size-69.56 Hectare approx.), Site-3: Balarampur, Gumar Gala (22° 48′ 68″ ′N & 88° 22′ 43″ E; Size-96.11 Hectare approx.). We would like to select the control wetland area (without any fly ash contamination) at Naldari, Burul, (22° 22′ 59.4″ N & 88° 06′ 49.5″ E; Size-106.23 Hectare approx.). The control wetland site is situated 15.4 Km(by road) away from the Budge Budge thermal power plant generating station. All the study areas are situated in South 24 Parganas District, West Bengal.

ii) Determination of the physico-chemical parameters of water at exposed(fly ash contaminated) and control wetland site

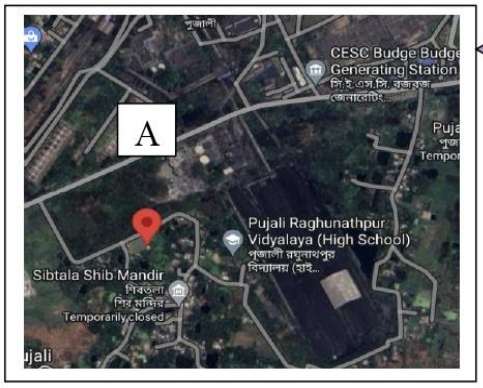
Various physico-chemical parameters of water from both the exposed and control wetland sites should be determined. Water should be collected with the help of Winkler bottle at 8:00 am. Parameters should be measured by following the standard protocol of **APHA** 23rd edition 2017.

LOCATION MAP OF STUDY AREA

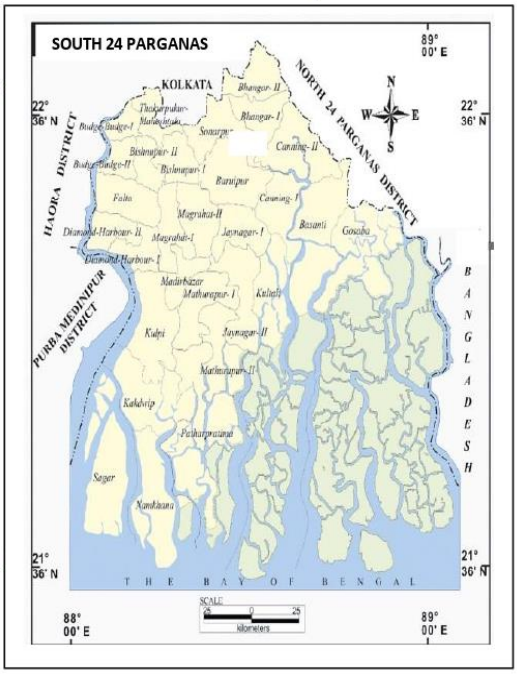




EXPOSED WETLAND SITE
(RAJARAMPUR, PUJALI)



CONTROLLED WETLAND SITE
(NALDARI, BURUL)



A	22° 27′ 45.6″N 88° 08′ 11.5″E
B	22° 22′ 59.4″N 88° 06′ 49.5″E

iii) Determination of physico-chemical parameters of soil at exposed(fly ash contaminated) and control wetland sites

Various physico-chemical parameters of soil from both the exposed and control wetland sites should be determined. The soil sample should be collected with the help of G.I. pipe (diameter 2inch) under 30 cm depth from the soil surface. The parameters should be measured by following the standard protocol of **APHA** 23rd edition 2017.

iv) Determination of floral frequency, abundance, and diversity at exposed(fly ash contaminated) and control wetland sites

All the floral species that are found during our study should be identified with the help of various taxonomic identification kyes(Bandyopadhyay and Mukherjee 2009, Some, and Mukherjee 2018)and confirmed by Botanical Survey of India(BSI), Kolkata. The faunal frequency, abundance and diversity should be measured by performing the quadrat study. Quadrat should be made off nylon rope and its size should be 2x2 feet. Ten random quadrats should be done at both the exposed and control wetland sites season wise(summer, monsoon, and winter). During the quadrat sampling all the aquatic and terrestrial plants should be photograph.

v) Determination of faunal frequency, abundance, and diversity at exposed(fly ash contaminated) and control wetland site

All the faunal species that are found during our study should be identified with the help of various taxonomic identification kyes(Das et al., 2014, Nandi et al., 2004)and confirmed by Zoological Survey of India(ZSI), Kolkata. The faunal frequency, abundance and diversity should be measured by performing the quadrat study. Quadrat should be made off nylon rope and its size should be 2x2 feet. Ten random quadrats should be done at both the exposed and control wetland site season wise(summer, monsoon, and winter). After collection of various aquatic and terrestrial animals, they should be preserved and examined under the bright field light microscope and photograph.

vi) Statistical Analysis: The statistical analysis should be performed by using the statistical software SPSS Statistics(Version 23.0, 2015).

Chapterization

Introduction

Chapter - 1: Geographical Background

Chapter - 2: Socio economic profile of the study area

Chapter - 3: Impact of fly ash on physico-chemical parameters of the water of the wetland

Chapter - 4: Impact of fly ash on physico-chemical parameters of the soil of the wetland

Chapter - 5: Impact of fly ash on wetland flora

Chapter - 6: Impact of fly ash on wetland fauna

Conclusion

Bibliography

Appendix

7. Sources of data and tools to be used in the collection of data

During the research work, the following instruments, chemicals, glass goods will be used for the collection of data–

Instruments

i) Quadrat made by nylon rope (2x2 feet)
ii) Thermometer (Alcohol)
iii) Plankton net (Bolting silk, mesh size:780)
iv) Hand dragging net for aquatic insects (Bolting silk, mesh size:780)
v) Secchi disk
vi) Sedgewick Rafter counting chamber,
vii) Flame atomic absorption spectrophotometer
viii) PH meter
ix) Digital Balance
x) GI pipe (for soil collection)
xi) Camera (Nikon)
xii) Microscope (Olympus)
xiii) GPS (Gramin)

Chemicals

xiv) 70% Alcohol
xv) 5% Formaldehyde

Glass goods

xvi) Slides
xvii) Forceps
xviii) Brush
xix) Trays (30x15 cm)
xx) Containers (Small 50 ml & Large 2L)

8. Analysis of data

i) Various physico-chemical parameters of water should be measured by following the standard protocol of APHA 23rd edition 2017.

ii) Various physico-chemical parameters of soil should be measured by following the standard protocol of APHA 23rd edition 2017.

iii) All the floral species that are found during our study should be identified with the help of various taxonomic identification kyes (Bandyopadhyay and Mukherjee 2009, Some, and Mukherjee 2018) and confirmed by Botanical Survey of India (BSI), Kolkata. The faunal frequency, abundance and diversity should be measured by performing the quadrat study.

iv) All the faunal species that are found during our study should be identified with the help of various taxonomic identification kyes (Das et al., 2014, Nandi et al., 2004) and confirmed by Zoological Survey of India (ZSI), Kolkata. The faunal frequency, abundance and diversity should be measured by performing the quadrat study.

v) The statistical analysis should be performed by using the statistical software SPSS Statistics (Version 23.0, 2015).

9. Significance of the study

i) Outcome of this research work should enlighten on different changes of various physico-chemical parameters of water as well as soil of wetland ecosystem.

ii) We might be familiar with the numerous types of floral and faunal species of the wetland ecosystem of our research area. We can also measure the toxic effect of the fly ash content on the species frequency, abundance, and diversity in the control wetland as well as exposed wetland.

Geography is a subject, which discuss the physical and human aspects. Wetland is an important part of bio-geography. It plays an important role in the environment. Wetlands are some of the most valuable ecosystems on Earth. They act like giant sponges or reservoirs. During heavy rains, wetlands absorb excess water, limiting the effects of flooding. Wetlands also protect coastal areas from storm surges that can wash away fragile beaches and coastal communities. Wetlands are highly productive and biologically diverse systems that enhance water quality, control erosion, maintain stream flows, sequester carbon, and provide a home to at least one

third of all threatened and endangered species. Wetlands are important because they: improve water quality. provide wildlife habitat. In this research,

10. Its relevance to the present-day problem and needs of the society

i) Encroachment of the wetlands may decrease the ground water level.

ii) Fly ash toxicity may alter the physico-chemical parameters of water of the wetland that may increase the heavy metal contamination in the ground water.

iii) Fly ash toxicity may change the physico-chemical parameters of soil of the wetland that may affect the production and quality of the agricultural crop products.

iv) Loss of floral and faunal diversity might be occurred due to filled up of the wetlands by fly ash.

v) Depletion of wetland may create the water logging or flooded condition in monsoon season. That may directly and indirectly increase various water-borne diseases (Jaundice, Cholera, Diarrhea, Typhoid etc.) and vector-borne diseases (Malaria, Dengue, Chikungunya, filaria etc.)

11. Contribution to the existing knowledge

Previous studies are most important part for any research work. For the formulation of research problem, selection of objectives and making hypothesis, the earlier studies play vital role. Thus, the study "Impact of fly ash on the wetland ecosystem of Budge Budge, South 24 Parganas District, West Bengal" related articles, research work, journals and books are very important.

Gupta et al., (2002)have briefly explained the properties of fly-ash and its environmental impacts and discusses some recent topics on quality control and remediation of fly-ash. They have also discussed on physico-chemical properties of fly ash, effect of fly ash on soil properties, and effect of fly ash on plant growth and vegetation.

According to **Kumar et al. (2013)** large quantity of fly ash and mercury generated from the thermal power plants have serious impacts on land, soil, air, and various social impacts. They suggested the requirement of a proper judicial environmental assessment before the commencement of the thermal power project in our country.

Bassia et al. (2014) have discussed about the status of wetlands in India. In this study, they have also reported the benefits, threats, and management strategies of wetland ecosystem

Spadoni et al. (2014) studied the impact of the disposal and re-use of fly ash from the Koradi and Khaperkheda thermal power plants (Maharashtra, India)on the water quality of wetland.

Das & Paul (2015) have studied the environmental and social impact of coal ash in the surrounding area of Kolaghat Thermal Power Station ,West Bengal.

Ghosh et al., (2015) have reviewed on the problems and management options of fly ash of the Bakreshwar thermal power plant, Eastern India.

Kanchan et al. (2015)have reported that the effect of fly ash disposal on ground water quality near Parichha thermal power plant, Jhansi.

Kakde and Sitre (2015)have investigated the effect of thermal power station effluents on wetland ecosystem in Maharashtra in India. In this, research they have found that the wetlands were ecologically deteriorated near the effluent disposal point of the thermal power plant. No algae, zooplankton and other biological components were recorded at the disposal point.

Bera (2016)has evaluated the impact of Bandel thermal power station (BTPS) on river Hugli through measuring physicochemical and microbiological parameters of the BTPS outlet, upstream and downstream water samples.

Das et al. (2016) have recorded some economically important aquatic plants of the wetland situated Katwa subdivision of Burdwan District, West Bengal, India. In this research they wanted to show the important role of aquatic plants in the society.

Mandal (2016) has evaluated the presence of toxic metals of fly ash which is causing ever-growing environmental problem including the pollution of air, water, and soil. This study also investigated how fly ash through manage as solid waste management program/process (fly ash brick, fly ash-based cement and fertilizer as agriculture) in order to save environment.

Pandey et al., (2017) have evaluated the environmental impact of leaching trace elements from fly ash dumps on aquatic ecosystem.

Some and Mukherjee(2018) have documented on some herbs and their medicinal uses at Chanchal Sub -Division of Malda District, West Bengal.In this study, they have also reported thatthe ethnic communities have immense knowledge on the medicinal and nutritional values of these herbs than our civil society. These herbs are earning source income of those socio-economic backward groups.

Xu et al. (2020)have described the different kinds of services of wetland ecosystem which are vital for human survival.

12. Future work

Based on the present research outcomes, we should plan the future work.

i) To determine the heavy metal composition of the fly ash content on different (physico-chemical) physiological system or in different tissue/organ level of different important wetland flora and fauna.
ii) How the changes in various physico-chemical parameters of water and soil can affect human and animals' life.
iii) We can initiate different the sustainable management and awareness programmed on wetland conservation and the important flora and fauna preservation.

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